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IS 12249 (1987): Specification for Desiccant Driers [MED 3: Refrigeration and Air Conditioning]

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Indian Standard (Reaffirmed 2001)

# SPECIFICATION FOR DESICCANT DRIERS

**1. Scope** — Covers the constructional features and the method of rating of driers which utilize solid desiccants and are designed for use in the liquid line of all refrigeration systems employing the following common halogenated hydrocarbons as refrigerants conforming to IS : 10609-1983 'Specification for refrigerants — Number designation' which have atmospheric boiling points lower than 20°C:

a) R 12, Dichlorodifluoromethane $CCl_2F_2$,

b) R 22, Chlorodifluoromethane $CHClF_2$, and

c) R 502, Azeotropes of R 22 and R 115.

**1.1** The subject of filtration is considered separate and distinct from the consideration of this standard. Therefore, the performance and rating of a drier is on the premise of a clean drier and clean refrigerant.

**1.2** Driers incorporating a monolithic core as the desiccant are also covered in the scope of this standard.

**Note** — It has been known that acid in a refrigeration system cause harmful corrosion. However, at the present time, there is no positive knowledge as to what concentrations of various acids is allowable or how to test a drier's ability to remove these acids. Therefore, the subject of acid removal is beyond the scope of this standard.

**2. Terminology** — For the purpose of this standard, the following definition shall apply.

**2.1** *Attribution Index of Desiccant Driers* — This is a ratio:

$$\text{Attribution Index} = \frac{\text{Weight of dry 100 mesh fines}}{\text{Weight of original sample}} \times 100$$

The test procedure for determining attribution index is given in **7**.

**2.2** *Drier* — A drier is a device containing desiccants. It is used in the liquid line of a refrigeration system for the primary purpose of collecting and holding water that may have entered the system — quantity of water held depends upon the quantity of desiccants in the drier.

**2.3** *Desiccant* — A solid that will collect and hold water while being itself totally insoluble in the refrigerant medium comprising the refrigerant, oil and water.

**2.4** *Equilibrium Point Dryness (EPD)* — The lowest possible water content of a liquid refrigerants attainable by a specific drier at a specific temperature, after an equilibrium has been reached between the water in the refrigerant and that in the drier. EPD is expressed in parts per million (ppm) by weight.

**2.5** *Water Capacity* — The amount of water which a drier will hold at a specified temperature and specified EPD level of water in a refrigerant. It may be expressed in drops or grams, 20 drops being considered equivalent to one gram.

**2.6** *Refrigerant Flow Capacity* — The maximum flow in tons of a specified refrigerant, which the drier shall permit at a specified pressure drop. The flow rate of the refrigerant, in kg per minute per ton, shall be as specified in **5.1**. The pressure drop shall be determined with tubing of the design size connected to the inlet and the outlet of the drier.

**3. General Construction**

**3.1** *Drier Body* — The body may be made of any suitable material compatible with the system of refrigerant. The thickness of material used shall be adequate and the method of manufacture including brazing/welding, etc, shall be sound and free from defects. The drier shall meet the strength and endurance requirements as specified in **6**.

**3.1.1** Typical design, construction and dimensions for desiccant driers have been given in Table 1, read with Fig. 1 A and 1 B. The pencil type driers shown in Fig. 1 A are for application in domestic refrigerators. Driers shown in Fig. 1 B are used in refrigeration plants.

**Note** — Design, construction and dimensions are for general guidance of the users.

Refrigeration and Air-conditioning Sectional Committee, EDC 66; Air-conditioning and Refrigeration Appliances and Commercial Refrigerators Subcommittee, EDC 66 : 1 [ Ref : Doc : EDC 66(4325) ]

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**TABLE 1 TYPICAL DESIGN, CONSTRUCTION AND DIMENSIONS FOR DESICCANT DRIERS**

All dimensions in millimetres.

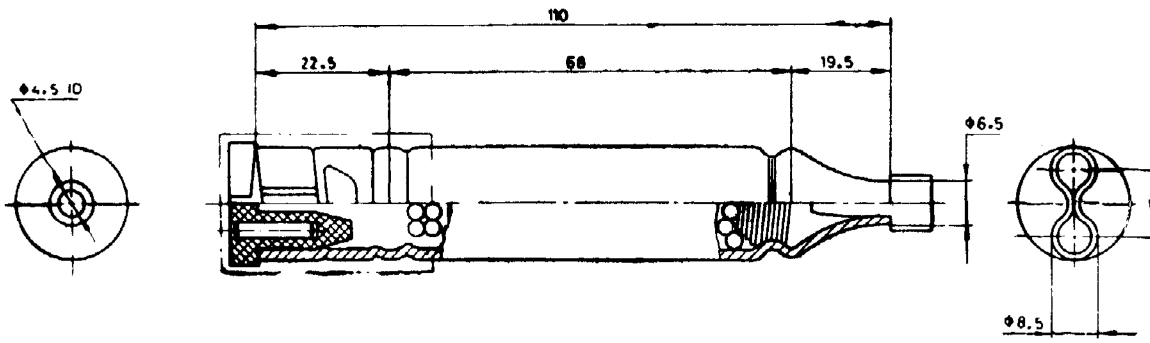


FIG. 1A PENCIL TYPE DRIER

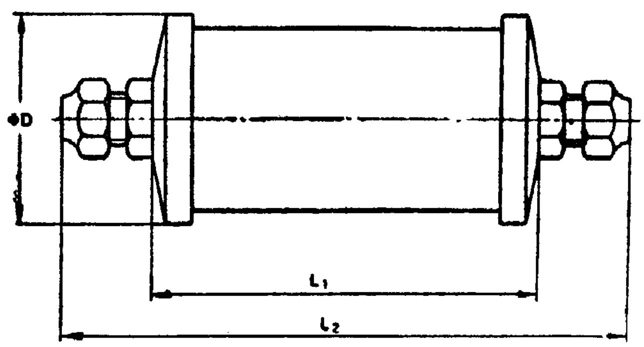


FIG. 1B DRIER FOR LARGE PLANT REFRIGERATION

| Type | End Connection (Flare) mm | Volume $cm^3$ | Length mm | | | Diameter $D$ mm |
|---|---|---|---|---|---|---|
| | | | Without Coupling Nut | $L_1$ | $L_2$ | |
| DESICCANT : SILICA GEL | | | | | | |
| DS-50 | 6 (1/4") | 56 | 97 | 50 | 109 | 55 |
| DS-85 | 6 (1/4") | 94 | 119 | 72 | 131 | 55 |
| DS-120 | 6 (1/4") | 133 | 141 | 94 | 153 | 55 |
| | 10 mm (3/8") | 133 | 147 | 94 | 161 | 55 |
| DS-200 | 6 (1/4") | 220 | 128 | 81 | 141 | 80.36 |
| | 10 (3/8") | 220 | 139 | 81 | 147 | 80.36 |
| DS-300 | 10 (3/8") | 330 | 162 | 108 | 174 | 80.36 |
| | 12 (1/2") | 330 | 169 | 108 | 181 | 80.36 |
| DS-500 | 10 (3/8") | 550 | 214 | 160 | 226 | 80.36 |
| | 12 (1/2") | 550 | 221 | 160 | 233 | 80.36 |
| DESICCANT MOLECULAR SIEVES | | | | | | |
| DM-45 | 6 (1/4") | 28 | 82 | 35 | 94 | 55 |
| | 10 (3/8") | 28 | 88 | 35 | 102 | 55 |
| DM-50 | 6 (1/4") | 56 | 97 | 50 | 109 | 55 |
| | 10 (3/8") | 56 | 103 | 50 | 117 | 55 |
| DM-85 | 6 (1/4") | 94 | 119 | 72 | 131 | 55 |
| | 10 (3/8") | 94 | 125 | 72 | 139 | 55 |
| DM-120 | 10 (3/8") | 133 | 147 | 94 | 161 | 55 |
| | 12 (1/2") | 133 | 155 | 94 | 170 | 55 |
| DM-200 | 10 (3/8") | 220 | 135 | 81 | 147 | 80.36 |
| | 12 (1/2") | 220 | 142 | 81 | 154 | 80.36 |
| DM-300 | 12 (1/2") | 330 | 169 | 106 | 181 | 80.36 |

**3.2** *Desiccant* — In most modern driers, the desiccant employed is either silica gel, molecular sieve or monolithic core.

**3.2.1** *Silica gel* — Silica gel is a synthetically produced silicon dioxide ( $SiO_2$ ) having an extremely porous structure. While, generally, it may conform to IS : 3401-1979 'Specification for silica gel (*second revision*)' for specific use in desiccant driers, it shall meet the requirements given in Appendix A.

**3.2.2** *Molecular sieve* — Molecular sieve is a synthetic zeolite, having the following general chemical composition:

$$X K_2O : Y Na_2O : 1 Al_2O_3 : 2 SiO_2 : n H_2O$$

**3.2.2.1** For use in refrigeration system, the type 4A-XH is used which would absorb molecules of size less than 4Å, thus precluding the adsorption of refrigerant and oil while including the moisture.

**3.2.2.2** Requirements for molecular sieve suitable for use in desiccant driers are given in Appendix B.

**3.2.3** *Core type desiccants* — These are of special design and construction and are considered acceptable if the desiccant drier fulfils the requirements of the standard.

**3.2.4** *Sieves sizes used with the driers*

**3.2.4.1** The test sieves shall conform to IS : 460 ( Part 1 )-1985 'Specification for test sieves : Part 1 Wire cloth test sieves (*third revision*)' and IS : 460 (Part 2)-1985 'Specification for test sieves : Part 2 Perforated plate test sieves (*third revision*)'.

The details of mesh sizes are as under:

a) 150 mesh with 0·5 mm perforated plate is used on outlet side in pencil type driers used in refrigerators, and

b) 150 mesh alongwith 80 mesh on outlet side and 80 mesh on inlet side alongwith 1 mm perforated plate is used in industrial air-conditioning with silica gel and molecular sieve driers (*see* also Appendix A and Appendix B).

**3.2.5** *Direction of flow* — The intended direction of flow of refrigerant shall be clearly marked on the body of the drier.

## 4. Standard Conditions for Specifying Ratings

**4.1** *Refrigerant Flow Rate* — Refrigerant flow capacity shall be referred to as tons flow based on +30°C liquid and −15°C saturated vapour temperatures, that is:

a) For refrigerant, R 12 : 1·82 kg per min per ton;

b) For refrigerant, R 22 : 1·32 kg per min per ton; and

c) For refrigerant, R 502 : 2·0 kg per min per ton.

**4.2** *Pressure Drop* — The flow capacity shall be determined at a pressure drop of 0·15 kgf/cm$^2$ across the drier. It shall be arrived at by dividing the observed flow in kg/min by the standard flow rates given in **5.1**.

## 5. Standard Test Methods for Determining Rated Capacity of Driers

**5.1** *Flow Capacity*

**5.1.1** *Principles of flow capacity testing* — The purpose of this test is to determine accurately the weight rate of flow when a specified refrigerant is flowing through the drier at a specified pressure drop. The test is run with clean refrigerant with a new uncontaminated drier. It should be noted that in actual use, the flow capacity may be less, depending on the degree of contamination. Performing such a test on a conventional refrigerating system involves numerous experimental difficulties, so 'liquid-pumped test loops', may be used as illustrated in Fig. 2.

**5.1.2** *Equipment* — The apparatus required for flow capacity testing is shown in Fig. 2. The requirements and limitations of the equipment are in accordance with Fig. 2.

**5.1.2.1** *Lines and arrangement* — The line size used throughout the system may be any convenient size so that the capacity of the system can be varied over a wide range of flow rate to accommodate testing of many size driers. However, the lines shall be the same size as the test drier fittings and shall be straight for a distance of at least 15 diameters upstream and 15 diameters downstream of the test drier.

**5.1.2.2** *Pump* — The pump shall be such that it shall produce steady-state, non-pulsating flow in an amount sufficient to maintain at least 0·21 kgf/cm$^2$ (or adequate for the requirements given in **5.1.3**) pressure drop across the drier being tested.

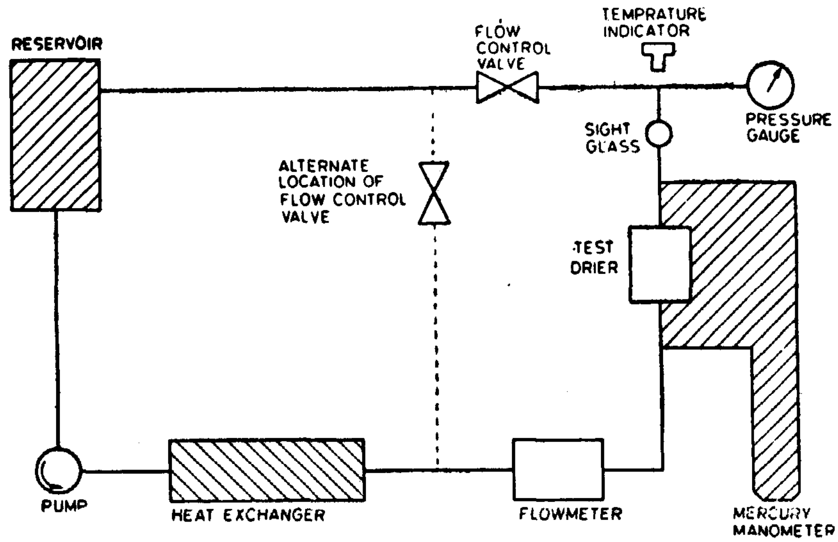


FIG. 2 SCHEMATIC DIAGRAM — LIQUID PUMP TEST LOOP

**5.1.2.3** *Heat exchanger* — A heat exchanger shall be provided to maintain a steady refrigerant temperature at 30 ± 5°C.

**5.1.2.4** *Flowmeter* — Any generally accepted type of flowmeter may be used, such as an orifice meter, venturi meter, rotameter, or positive displacement meter, provided that the meter is of such a construction and is installed in such a way that it does not create undue turbulence or disturb the steady state flow in the system. Since this meter is a very vital part of the apparatus, it shall be calibrated to assure that any error in indicated flow is less than 5 percent.

**5.1.2.5** *Manometer* — The pressure drop across the test drier shall be measured by a mercury manometer or other means with a maximum error of 0·003 $kgf/cm^2$ or less. The manometer reading shall be corrected for the effect of the refrigerant column on top of the mercury. The pressure taps should be located at least two diameters upstream of the drier and ten diameters downstream of the drier. 1·5 mm diameter burr-free holes shall be used for pressure taps, except in 6·25 mm or less diameter tube where 0·75 mm diameter holes shall be used.

**5.1.2.6** *Sight glass* — A sight glass shall be installed on the downstream side of the test drier so that a visual check can be made to assure that no flash gas is present in the refrigerant.

**5.1.2.7** *Temperature indicator* — An indicator shall be installed to measure the refrigerant temperature at the downstream side of the test drier. This indicator as installed shall not disturb the refrigerant flow. The type of instrument, its calibration, and its installation shall be such as to assure that any error in indicated temperature is less than 1·5°C.

**5.1.2.8** *Flow control valve* — Means shall be provided to manually adjust the flow rate through the test drier so that the pressure drop can be set at various values in the range from 50 to 150 percent of the specified pressure drop.

**5.1.3** *Test procedure* — Install the test drier, adjacent lines, and pressure taps as described above. Charge the system with an adequate amount of the specified refrigerant.. Remove the non-condensable gases (air) from the system. Circulate the refrigerant through the loop. Adjust the flow control valve to give at least five different operating conditions between 50 and 150 percent of the specified pressure drop. Record the flow rate and pressure drop data for at least five different, steady state, operating conditions.

**5.1.4** *Handling of test data*

**5.1.4.1** Correct the observed flow rate data for instrument calibration, and convert to kg per minute units.

**5.1.4.2** Correct the observed pressure drop for the effect of the refrigerant column above the mercury, and convert to $kgf/mm^2$ units.

**5.1.4.3** Plot a point for each of the several operating conditions recorded for a particular test drier on a graph of flow rate versus pressure drop. Interpolate between these points to determine the flow capacity of this particular drier at the specified pressure drop.

**5.1.4.4** The flow capacity, expressed in kg per minute, shall be converted to tons by dividing the kg per minute by the specific refrigerant circulation rate as specified in **5.1.1**, **5.1.2** and **5.1.3**.

**Note** — Experience has proven that it is permissible to extrapolate flow capacity data, experimentally determined for one refrigerant, to the other common refrigerants by using the relationship that the weight rate of flow for constant pressure drop is proportional to the square root of the liquid refrigerant density.

5.2 *Water Capacity*

5.2.1 *Principle* — The test method involves adding a known amount of water to the test drier, passing refrigerant through this drier at a very slow rate while keeping the drier at a fixed temperature, then determining EPD of the effluent refrigerant by gravimetric analysis in a phosphorus pentoxide drying train.

Note — It has been demonstrated that at the slow flow rate specified, equilibrium conditions are achieved.

5.2.1.1 To make a comprehensive evaluation of a drier, it is necessary to repeat the above procedure with various amounts of water added to each of several driers, and various fixed temperatures. This permits the plotting of isotherm curves of EPD versus water capacity. This entire procedure shall be repeated with each of the different refrigerants for which it is desired to evaluate the drier.

5.2.2 *Apparatus*

5.2.2.1 An analytical balance for weighing. Nesbitt bulbs having a sensitivity of 0·000 1 g and capacity of 200 g.

5.2.2.2 A balance for weighing refrigerant supply cylinders, having a sensitivity of 1·0 g and a capacity of 5 000 g.

5.2.2.3 A balance for weighing driers having capacity sufficient for weighing the particular drier being tested and a sensitivity of less than 3 percent of the weight of water being added to the drier.

5.2.2.4 A weighing train (*see* Fig. 3) composed of two Nesbitt type bulbs and a flow indicator joined in series. The Nesbitt bulbs are filled with a mixture of equal parts by weight of phosphoric anhydride and dried asbestos fibres and have layers of glass fibres for filter mats, both above and below the desiccant. The second (last) bulb protects the first from moisture infiltration, and is generally used as a counterpoise when weighing the first bulb.

5.2.2.5 An air drying train including a gas scrubbing tower filled with phosphoric pentoxide (anhydrous). Preliminary drying towers may be placed ahead of this and filled with a suitable desiccant in order to remove most of the water from the air stream and minimize the duty of the phosphoric anhydride tower (*see* Fig. 4).

5.2.2.6 A closed, air circulating loop with a pump and other hardware (*see* Fig. 5) for adding water to sample driers. The pump shall be capable of delivering 28 to 56 l/min of oil-free air.

5.2.2.7 Liquid refrigerant supply cylinders having a capacity of approximately 2·8 litres. These cylinders shall be properly cleaned, dried and evaluated.

5.2.2.8 Metal tubing flare fittings and valves as required to complete the assembly have been shown in Fig. 6.

5.2.2.9 A constant temperature bath or cabinet which will maintain the apparatus in Fig. 6 at a given set temperature with an accuracy of ± 0·5°C and capable of being set at any temperature within the range of desiccant use. When a constant temperature bath is used above room temperature, the refrigerant supply cylinder should be warmed 2·5 to 5°C above the bath temperature with a heating mantle. The entire apparatus may be placed inside a constant temperature cabinet.

5.2.2.10 Assembled equipment shall be adequately dried and leak tested.

5.2.3 *Preparation of the test drier* — Install the test drier in an air circulating loop such as shown in Fig. 5. The drier shall be installed backward, so that the air will flow into drier through the normal outlet connection. Introduce the desired amount of water into the saturator. Install the entire air circulation loop in a cabinet held at a temperature of 76·5 ± 2·5°C, and operate the circulation for at least 24 hours.

Note — The purpose of this is to achieve uniform distribution of water through the desiccant.

5.2.3.1 The test drier shall be weighed before and after this operation. The difference in weight is the water added. Accuracy of weighing shall be such that the error is a maximum of 3 percent of the weight of the water added.

5.2.3.2 *Precautions*

a) Since any loss of volatiles such as from the exterior finish would introduce an error in determination of the amount of water added, it is generally advisable to prebake the drier for several hours at 95°C, and .

b) The weight of water introduced into the saturator shall not be used as the weight added to the drier due to the possibility of leakage and migration of moisture through fitting, connections, seals, etc.

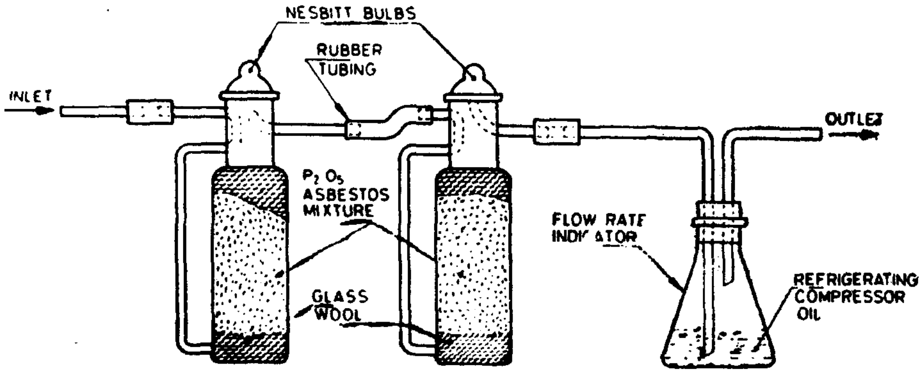


FIG. 3 WEIGHING TRAIN

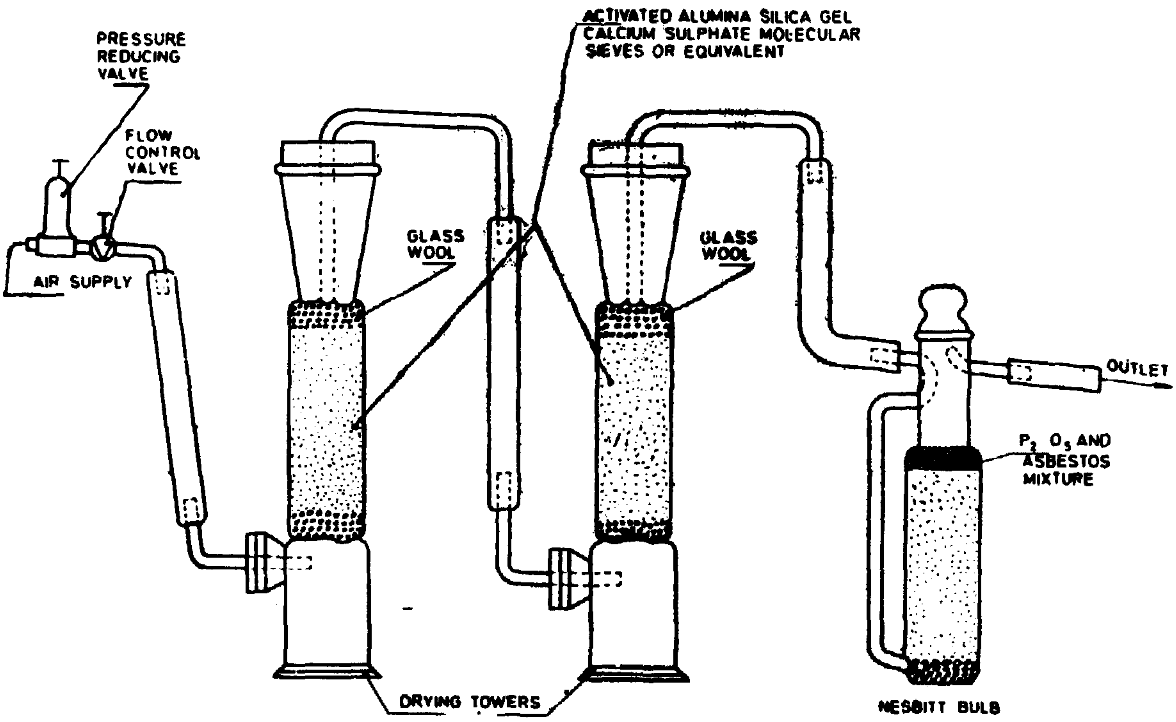


FIG. 4 DRY AIR TRAIN

**5.2.4** *Preparation of refrigerant* — A commercial grade of the refrigerant, to be used with the drier, shall be employed in the test under this standard, and shall be oil-free. The refrigerant shall be charged into the supply cylinder leaving at least 25 percent of the volume for vapour phase.

**5.2.5** *Determination of equilibrium point dryness (EPD)*

**5.2.5.1** Install the test drier, to which a known amount of water has been added (*see* **5.2.3**), in the apparatus shown in Fig. 6. Note that the refrigerant flowing from the supply cylinder, through the drier to the needle valve, *C*, shall flow through the drier in the direction as specified by the manufacturer.

**5.2.5.2** With the drier in a vertical position, the outlet at the top, and with valve, *C*, slightly open, admit liquid refrigerant through valves *A* and *B* from the refrigerant supply cylinder so that the air is displaced from the drier. Close the valve *C*. Some heating of the drier may occur as refrigerant wets the desiccant.

**5.2.5.3** After the drier is cooled, open the valve *C* slightly, to vent gas to the atmosphere and to completely fill the drier with liquid refrigerant. As long as gas escapes through the valve *C*, no appreciable cooling of the exit tube occurs, but when all gas is displaced, liquid refrigerant escapes and cools the tubing beyond the valve. Close the valve *C*.

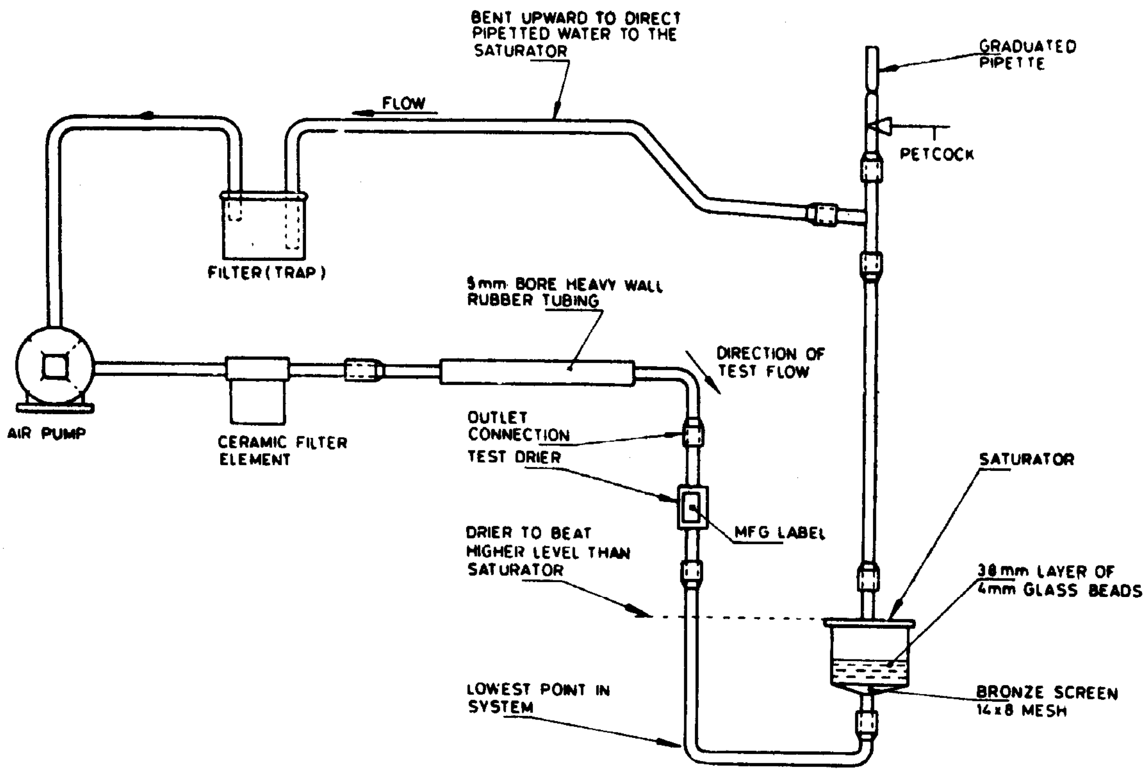


FIG. 5 APPARATUS FOR ADDING TEST CAPACITY WATER TO SAMPLE DRIERS

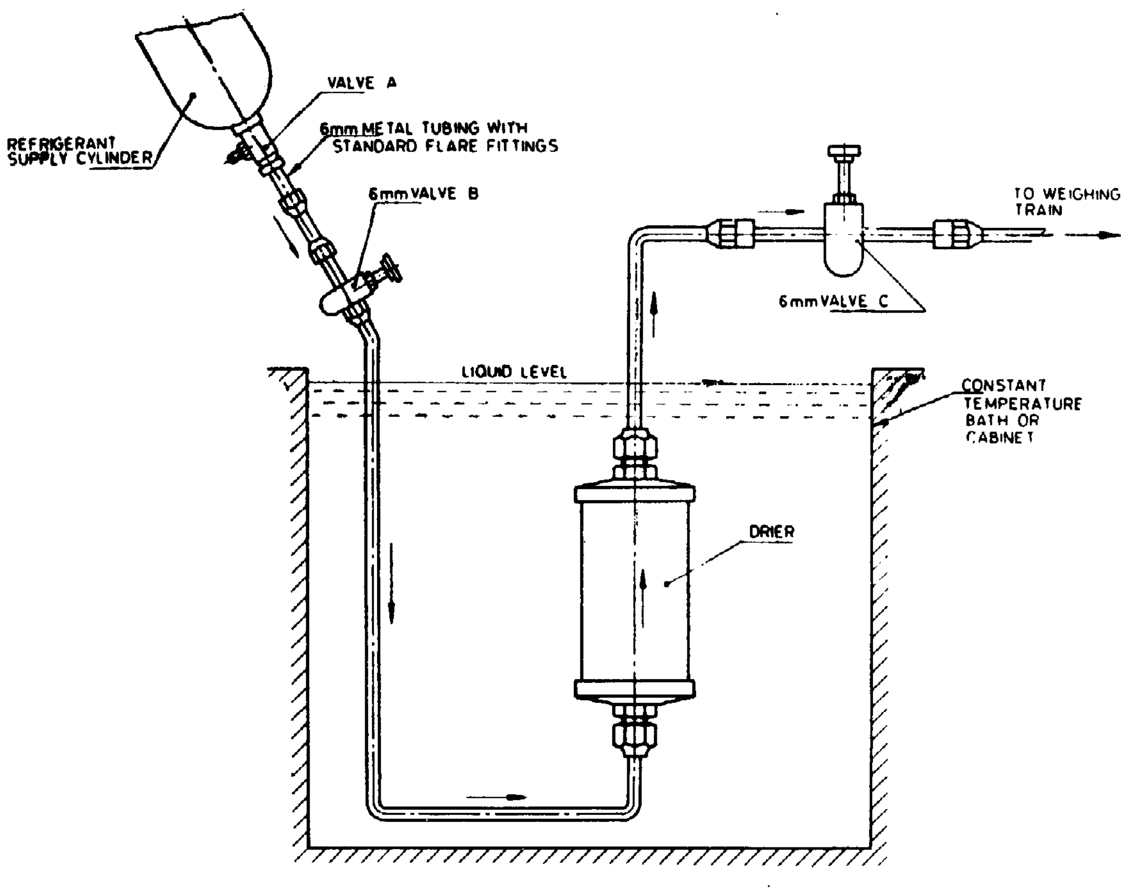


FIG. 6 APPARATUS FOR DETERMINATION OF EDP

**5.2.5.4** Place the charged drier with supply cylinder attached (valves *A* and *B* still open) in the constant temperature bath (or cabinet), as shown in Fig. 6, and allow it to stand overnight or about 16 hours. Check the system for leaks.

**5.2.5.5** Pass about 15 litres per hour of dry air, attained by passing the air through the drying train (Fig. 4), through the weighing train for sufficient time to achieve dry equilibrium conditions, as indicated by constant weight of the Nesbitt bulbs. Record the weight of the 'weighing' Nesbitt bulb. In this and subsequent weighings of the Nesbitt bulb, avoid handling with the bare hands, use tongs having flat cork tips, and remove dust from the bulb exterior with a soft brush.

**5.2.5.6** Remove, weigh and reinstall the refrigerant supply cylinder. Replace the metal tube downstream of valve *C* with a similar one which has been properly dried, and connect the weighing train to the outlet end of the tube.

**5.2.5.7** Open valves *A* and *B* wide and 'crack' valve *C* so that several bubbles per second of gas pass through the system at a rate not to exceed about 30 grams per hour. The flow rate indicator may be used to estimate the flow rate. After a minimum of 200 grams of refrigerant has passed through the absorption train, close all the valves.

**5.2.5.8** Disconnect the refrigerant supply cylinder and weigh to determine the amount of refrigerant used. Correct the weight of the refrigerant for the refrigerant held between valves *A* and *B*. Disconnect the weighing train and purge with dry air (approximately 14 l/hour) to constant weight and weigh to determine the amount of water absorbed.

**5.2.5.9** Calculate the refrigerant EPD, as parts per million (ppm), by dividing the weight of water picked up in the phosphorus pentoxide drying train by the weight of refrigerant passed through the apparatus.

$$\text{EPD} = \frac{\text{grams of water in } P_2O_5}{\text{grams of refrigerant}} \times 10^6 \text{ ppm}$$

**5.2.5.10** The water capacity of the test drier at the above determined EPD is the water added (*see* **5.2.3** and **5.2.3.1**).

**5.2.5.11** Water capacity at other EPD's shall be determined by repeating the determination of EPD (*see* **5.2.5**) a number of times but with different amount of water added to the test drier (*see* **5.2.3**). A plot of these results on a graph of water capacity versus EPD shall produce a smooth curve and may be used to establish water capacity at any specified EPD.

**5.2.6** *Proof of equilibrium* — Proof that equilibrium exists or that a chemical reaction may be occurring in a system comprising the drier, the refrigerant, and water shall be obtained by the following procedure.

**5.2.6.1** The apparatus shown in Fig. 6, containing a drier with relatively high water content is, at the conclusion of the procedure **5.2.5** kept for a period of two weeks at 52°C. Procedure as specified in **5.2.5** is then repeated. If the EPD checks within 2 ppm or 10 percent of that obtained, equilibrium has been proven. If check results are not obtained, repeat procedure. A persistent and appreciable change in EPD may indicate a chemical reaction and may serve as the basis for rejection of the drier.

**5.2.7** *Statistical method of determining the water capacity* — The statistical method of determining the water capacity has been described in Appendix C.

## 6. Strength and Endurance Requirements

### 6.1 *Strength Requirements*

**6.1.1** *Pencil type driers* — The drier must withstand without leakage, a working pressure of 10 kgf/cm$^2$ when tested with dry air in an alcohol bath. Burst pressure shall not be less than 20 kgf/cm$^2$.

**6.1.2** *Driers for refrigeration plants* — These driers shall not show any leakage when tested with dry air at 28 ± 2 kgf/cm$^2$ in an alcohol bath. Burst pressure shall not be less than 105 kgf/cm$^2$.

### 6.2 *Endurance Requirements*

**6.2.1** All driers shall successfully pass the leak test after being subjected to $10^6$ cycles of pulsating pressure varying between 7 and 9 kgf/cm$^2$ for pencil type driers and 12 to 20 kgf/cm$^2$ for larger driers, with a frequency of 140 cycles/minute.

## 7. Test Procedure for Determining Attribution Index

**7.1** Measure 136 ml of the beads and weigh to the nearest 0·1 g. Take 210 ml bottle (100 mm high) and transfer the weighed sample. Add 68 ml of trichloroethylene and seal the bottle. Place the bottle on a paint shaker, and allow shaking for 30 minutes. Remove bottle from the shaker and carefully wash off and strain the fine dust particles through a 100 mesh screen with trichloroethylene. Allow the fines to settle, decant the liquid and dry the fines at 120°C. Cool and weigh to the nearest 0·01 g.

**7.1.1** The attribution index of the desiccant, determined according to above method, shall not be more than 0·25 percent.

**7.1.2** The requirements for paint shaker has been given in Appendix D.

## APPENDIX A

[*Clauses* 3.2.1 *and* 3.2.4.1 (b)]

### REQUIREMENTS OF SILICA GEL FOR USE IN DESICCANT DRIERS

**A-1. Chemical Composition**

a) $SiO_2$ : 95 - 100 percent,

b) $Al_2O_3$ : 0 - 5 percent, and

c) Impurities : 0·5 percent, *Max.*

**A-2. Properties**

**A-2.1** *Shooting Weight* — Not less than 0·70 kg/l (dry desiccant).

**A-2.2** *Shaking Weight* — 0·83 kg/l, *Max* (dry desiccant).

**A-2.3** *Granular Shape* — Minimum 53 percent of the granules shall be whole. A pearl is considered whole when there are no scratches in the surface and when it has retained 75 percent of its original size.

**A-2.4** *Size of Granules* — The following result is required of sieve analysis (regarding sieve sizes, *see* **3.2.4**):

a) On sieve No. 3 : 0·2 percent, *Max* shall remain by weight;

b) On sieve No. 6 : 60 percent, *Max* shall remain by weight;

c) On sieve No. 10 : 98·8 percent, *Min* shall remain by weight; and

d) On sieve No. 18 : 99·8 percent, *Min* shall remain by weight.

**A-2.5** *Compression Strength* — The compression strength of the whole fully saturated granules shall correspond to the following values:

a) For 50 percent of the granules : 10 kg, *Min*; and

b) For 99 percent of the granules : 1 kg, *Min.*

**A-2.6** *Wearability* — 0·2 percent, *Max* by weight through sieve No. 30.

**A-2.7** *Water Content* — 0·5 percent, *Max* by weight.

**A-2.8** *Absorption Capacity at Equilibrium with Moisture* — 33 percent, *Min* by weight at 25 ± 1°C and 80 percent relative humidity.

**A-3. Packing**

**A-3.1** Shall be supplied in plumbed moisture-proof containers.

**A-3.2** Normally, a slight vacuum is provided in the sealed container.

## APPENDIX B

[*Clauses* 3.2.2.2 *and* 3.2.4(b)]

### REQUIREMENTS OF MOLECULAR SIEVES FOR USE IN DESICCANT DRIERS

**B-1. Properties**

**B-1.1** *Shooting Weight* — 0·720 kg/l, *Max* (dry desiccant).

**B-1.2** *Shaking Weight* — 0·850 kg/l, *Max* (dry desiccant).

**B-1.3** *Granular Form* — The granules shall be approximately spherical and shall not have sharp edges. The granules shall not contain more than 3 percent by weight, of fragments.

**B-1.4** *Size of Granules* — The balls shall correspond to 4 × 8 mesh (regarding sieve size, *see* **3.2.4**)

a) Through sieve No. 4 : 100 percent, shall fall through;

b) On sieve No. 8 : 95 percent, *Min* shall remain;

c) On sieve No. 20 : 99 percent, *Min* shall remain; and

d) Through sieve No. 100 : 0·05 percent, *Max* shall fall through.

**B-1.5** *Compression Strength* — The compression strength of the moisture saturated desiccant balls shall correspond to the following values:

a) For 99·5 percent of the balls : 1·5 kg, *Min*;

b) For 84 percent of the balls : 5·0 kg, *Min*; and

c) For 50 percent of the balls : 7·3 kg, *Min*.

The values stated are applicable for a normal (Gaussian) distribution.

**B-1.6** *Wearability* — The wearability of the desiccant shall be 3·0 percent, *Max* by weight.

**B-1.7** *Water Content* — The water content shall not exceed 1·5 percent by weight.

**B-1.8** *Absorption Capacity* — At a water vapour partial pressure of 17·5 mmHg at 22 to 30°C, the desiccant shall be able to absorb not less than 16·0 percent by weight, of water.

**B-1.9** *Resistance to Oil-Refrigerant Mixtures* — While placed in mixtures of refrigerator oil and refrigerants R 12 and R 22 at temperature between boiling point for pure refrigerant and +90°C, the desiccant shall not go below the values specified.

**B-2. Packing**

**B-2.1** Shall be supplied in plumbed, moisture-proof container.

**B-2.2** Normally a slight vacuum is provided in the sealed container.

## APPENDIX C

( *Clause* 5.2.7 )

### STATISTICAL METHOD FOR DETERMINATION OF WATER CAPACITY

**C-1.** This presents a statistical method applied to the results from testing sets of samples of production driers to establish a rating which will be equalled or exceeded by 90 percent of those produced.

**C-2. Introduction**

**C-2.1** When several determinations of the equilibrium point dryness ( EPD ) of a single drier are made by the procedure given in **5.2.5**, a series of values will be obtained because of variations in analytical procedure. The average of these results is more reliable than any single result. This average also becomes more reliable as more values are used in the calculation of the average.

**C-2.2** When the average EPD of second drier is calculated from several determinations, this value will differ from the average of the first drier because of the manufacturing variations. The overall average of the two driers is more representative of the production line driers than is the average of a single drier. The overall average of several driers is still more representative.

**C-2.3** In order to compensate for these testing and manufacturing variations, a statistical procedure is available for arriving at a rating that will guarantee any percent compliance desired.

**C-2.4** This rating procedure is statistical analysis of results obtained from tests on a group of six driers, and the rating obtained by this procedure will be such that the average water capacity of duplicate tests on any set of six driers will equal or exceed the rating in 90 percent of all cases.

**C-2.4.1** The proforma for report of observed ratings for water capacity and refrigerant flow capacity at standard rating conditions is given below:

| PROFORMA FOR REPORT OF RATINGS | | | | | |
|---|---|---|---|---|---|
| *Refrigerant* | *Standard Rating Conditions* | | | *Ratings* | |
| | Group No. | Standard Temp. | Water in Refrigerant (EPD) | Water Capacity | Refrigerant Flow Capacity at 0·14 kg/cm$^2$ Pressure Drop |
| | | °C | ppm | drops | tons |
| Refrigerant, R 12 (dichlorodifluoromethane $CCl_2F_2$) | I | 24 | 15 | | |
| | II | 52 | 15 | | |
| Refrigerant, R 22 (chlorodifluoromethane $CHClF_2$) | III | 24 | 60 | | |
| | IV | 52 | 60 | | |
| Refrigerant, R 502 (chlorodifluoromethane/monochloropentafluoroethane, R 22/R 115) | V | 24 | 30 | | |
| | VI | 52 | 30 | | |

**C-3. Rating Procedure**

**C-3.1** *Preliminary* — The approximate water capacity of a drier shall first be determined by the test procedure outlined in **5.2**. Two driers for each standard condition are usually sufficient for this determination.

**C-3.2** *Procedure* — Three driers are then pre-loaded at this pre-determined capacity. Duplicate EPD determinations are made for each drier. The average EPD for each drier and the overall average for the six determinations is then calculated. Another set of three driers is then evaluated at an adjusted capacity so that the overall average EPD's of the two sets will bracket the standard EPD.

**C-3.2.1** In this procedure, duplicate EPD determinations per drier are required. This procedure slightly reduces the variations inherent in the method. Most important, it provides a check on the precision of the method. The maximum range for duplicate EPD determinations shall not exceed the following:

a) Refrigerant, R 12 : 3 ppm,

b) Refrigerant, R 22 : 6 ppm, and

c) Refrigerant, R 502 : 6 ppm

If the above range is exceeded, the test data shall be discarded, and the test shall be repeated after the analytical procedure has been reviewed.

**C-3.2.2** The two EPD set averages are plotted on graph paper, plotting capacity on the vertical axis and EPD on the horizontal axis. A straight line is drawn between these two points. A vertical line is drawn from the standard EPD to the straight line. A horizontal line is then drawn from the point of intersection to the vertical axis. This point of intersection with the vertical axis gives the 'set average' at the standard EPD.

**C-3.2.3** The six individual 'duplicate averages' are now plotted on the same graph. The vertical distance of each point from the straight line is determined in the units of capacity. The maximum value above the line is added to the maximum value below the line. The sum of these values is called the 'range'.

*Typical Example* :

*Data Collected* :

| 90 Drops of Water Added | | | 110 Drops of Water Added | | |
|---|---|---|---|---|---|
| Drier No. | EPD | Average | Drier No. | EPD | Average |
| 1 | 10·5<br>12·0 | 11·2 | 4 | 18·5<br>20·0 | 19·3 |
| 2 | 13·0<br>14·5 | 13·8 | 5 | 15·0<br>16·0 | 15·5 |
| 3 | 13·0<br>14·0 | 13·5 | | 13·0<br>15·0 | 14·0 |
| Average | 12·8 | | Average | 16·2 | |

*Determination of Range* :

Range = 13 + 18 = 31 drops.

*Determination of Set Average* :

Enter the chart at EPD of 15 ppm, and read vertically to intersection with capacity line. Proceed horizontally and read capacity of 103 drops.

*Sample Calculations* :

Water capacity rating (based on set of 6 driers) = 103 − 0·36 (31) = 92 drops.

**C-3.2.4** By using the 'set average', the 'range', and a multiplication factor of 0·36 taken from the statistical tables, the water capacity rating is calculated as follows:

Water rating $= A - 0{\cdot}36r$

where

$A$ = set average, and

$r$ = range.

**C-3.2.5** When driers are preloaded at the rated water capacity, it can be guaranteed that at least 90 percent of averages of sets of six driers, with duplicate tests for each drier, will equal or exceed the rating.

# APPENDIX D

(*Clause* 7.1.2)

## RECOMMENDED REQUIREMENTS FOR PAINT SHAKER

| | |
|---|---|
| No. of can holders | : One |
| Maximum can diameter | : 180 mm |
| Holder opening height | : 250 mm |
| Can size | : 5 litres and below |
| Operating space required (width × depth × height) | : 600 × 400 × 400 mm |
| Timer | : 15 minutes, automatic |
| Lubrication | : Oil bath |
| Prime mover (electric motor) | : 0·5 HP, 440 V, 3-phase, 960 rev/min, 50 Hz. |

# EXPLANATORY NOTE

This standard has been prepared based upon the experience of our industry. The dimensions and construction of the desiccant driers recommended in this standard is based upon the design which is found to be successful on operation.



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